Optical & NIR photometry of the interacting Dwarf Galaxies II Zw 70/II Zw 71 *

P. Papaderos[1], K.G. Noeske[1], L.M. Cairós[2], J.M. Vílchez[3], K.J. Fricke[1]

[1]Universitäts-Sternwarte Göttingen, D-37083 Göttingen, Germany
[2]IAC, 38200 La Laguna, Tenerife, Spain
[3]IAA (CSIC), 18080 Granada, Spain

Abstract

We obtained deep optical and NIR images of the pair of blue compact dwarf (BCD) galaxies II Zw 70 and II Zw 71 in order to study the effects of interaction on the structural properties of their stellar low-surface-brightness (LSB) component. We find that within their Holmberg radius the interacting BCDs under study do not differ significantly in terms of the central surface brightness and exponential scale length of their LSB hosts from typical iE/nE systems. In the faint outskirts ($26.2 \lesssim \mu_B$ [mag/□″]$\lesssim 28.5$) of both systems, however, the present data reveal conspicuous morphological distortions, most notably an extended feature protruding as far as ∼9 kpc from the starburst region of II Zw 70 in the direction of II Zw 71. The relatively blue colors of this stellar extension, together with its apparent spatial coincidence with the massive HI streamer connecting the dwarf galaxies, are consistent with the hypothesis that it originates from recent star formation within the gaseous halo of II Zw 70, rather than from stellar matter torn out of the LSB host of the BCD during the interaction. The results presented here support the view that important signatures of the dynamical response and secular evolution of the stellar LSB component in interacting dwarf galaxies can be found in their very faint outskirts.

1 Introduction

Research on galaxy interactions has so far mainly focussed on normal galaxies. However, given the large number ratio of dwarf-to-normal galaxies in the local Universe, close encounters among gas-rich dwarf galaxies may not be rare and have a considerable impact on the star formation history and dynamical state of these systems. Whether interaction/merging with a faint stellar or gaseous companion is the genuine process driving starburst activity in blue compact dwarf (BCD) galaxies (cf. eg. Taylor et al. 1995, Bergvall et al. 1999) is a subject of debate. However, the hypothesis that interactions can efficiently trigger star formation activity in gas-rich dwarfs received observational support by a number of recent studies (e.g. II Zw 33, Walter et al. 1997, Méndez et al. 1999; ESO 338-IG04, Östlin et al. 1998; HCG 31, Iglesias-Páramo & Vílchez 1997; Mkn 86, Gil de Paz et al. 2000).

Here, we present first results from a spectrophotometric study of the pair of interacting iI BCDs II Zw 70 and II Zw 71 (Fig. 1a). At the assumed distance of 18.2 Mpc, the angular separation of 4.′05 between the BCDs corresponds to a projected linear separation of 21.5 kpc. The ongoing interaction is indicated by interferometric HI studies (Balkowski et al. 1978, Cox et al. 2001)

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Table 1: Summary of the observations

Instrument	t_{exp} [min]					
	U_J	B_J	V_J	R_c	I_c	Hα; Hα_cont
CA2.2/CAFOS	60	70	10	30	20	—
NOT/ALFOSC	15	27	22	27	25	25; 25
Total	**75**	**97**	**32**	**57**	**45**	**25; 25**
	II Zw 70			II Zw 71		
	J	H	K'	J	H	K'
CA3.5/Ω Prime	38	7	17	18	6	22
WHT/INGRID	27	6	8	16	12	8
Total	**65**	**13**	**25**	**34**	**18**	**30**

which revealed a gaseous streamer connecting II Zw 70 with the polar ring galaxy candidate II Zw 71 (Whitmore et al. 1990, Reshetnikov & Combes 1994). To study the effects of interaction on the *stellar* component of both BCDs we have obtained deep images in the optical and NIR (see Table 1). These allow us to investigate the photometric properties of the low-surface-brightness (LSB) stellar host of both BCDs by means of surface photometry and search for morphological signatures of the interaction in their outskirts.

2 Observations and data reduction

Optical broad band and Hα data of II Zw 70/71 were obtained during several observing runs with the 2.2m Calar Alto Telescope equipped with CAFOS and the 2.5m Nordic Optical Telescope (NOT) with ALFOSC. Near–Infrared exposures were taken with OMEGA PRIME at the Calar Alto 3.5m telescope, and with the recently commissioned INGRID camera at the ING 4.2m William Herschel Telescope (WHT). All reduced single images in each band were aligned, adapted to equal seeing, and coadded weighting each one by its S/N. Optical and NIR data were calibrated through observations of standards and using field stars from the 2MASS catalogue. Surface brightness profiles (Fig. 2ab) were computed and decomposed into the luminosity part attributable to the underlying (typically exponential) stellar LSB host and that of the superimposed younger stellar population. The available data allow for surface photometry studies down to a surface brightness level of ∼28.5 mag/□″ and 24.0 mag/□″ in B and J, respectively.

3 Results and Discussion

The surface brightness profiles of both BCDs can be approximated by an exponential fitting law at radii where the luminosity contribution of the starburst becomes small (II Zw 70: $16'' \lesssim R^* \lesssim 24''$, II Zw 71: $26'' \lesssim R^* \lesssim 35''$). For the LSB hosts of II Zw 70 and II Zw 71 we derive, respectively, a B band central surface brightness of 22.2±0.15 mag/□″ and 21.2±0.1 mag/□″ and an exponential scale length of 580 pc and 675 pc. Such structural properties are in the range of those inferred previously for LSB hosts of iE/nE BCDs (cf. e.g. Papaderos et al. 1996, Cairós 2000). Therefore, no hint towards a significant deviation from the typical stellar distribution in the LSB host of BCDs is present, at least on a radial scale of ∼ 4 exponential scale lengths. The average colors of the LSB component of either BCD (II Zw 70: $B-R \lesssim +0.8$ mag, $B-V$=+0.4 mag; II Zw 71: $B-R$=+1.0 mag, $B-V$=+0.5 mag) are consistent with an evolved stellar background with an age of 1–3 Gyr and $\geq$ 4 Gyrs for II Zw 70 and II Zw 71, respectively (cf. Cairós 2000).

At a surface brightness level fainter than ∼26.2 B mag/□″ the intensity distribution of the less massive interacting counterpart, II Zw 70, shows a marked deviation from the exponential slope inferred above, getting a scale length of ∼900 pc and a central surface brightness of ∼23.4 B mag/□″. This outermost intensity regime, contributing ∼18% of the total B band emission of

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Figure 1: **(a)** Combined *B* band exposure of the BCD pair II Zw 70/71. The field of view is $5\overset{'}{.}7 \times 3\overset{'}{.}8$ and the total exposure time 1.6 hr. North is up, east to the left. The extended asymmetric feature NW&SE aligned nearly perpendicular to the main body of II Zw 70, is visible for surface brightness levels $\gtrsim$26 *B* mag/$\square''$. The insets show $B - R$ color maps of II Zw 70 and II Zw 71 displayed in the range 0.4–0.8 mag and 0.4–1.0 mag, respectively. **(b)** HI map of the pair II Zw 70/71, reproduced from Balkowski et al. (1978). A recent interferometric study with the VLA (Cox et al. 2001) has shown that the HI streamer connecting II Zw 70 and II Zw 71 has a mass of 2.5×10^8 $M_\odot$, equivalent to 28% of the total HI mass of the pair. **(c&d)** Contour maps of II Zw 70 and II Zw 71 in the *B* band. In both plots the 26 *B* mag/$\square''$ isophote is indicated by the thick contour. Note the marked extension labelled SE in the contour map of II Zw 70 protruding $\gtrsim 100''$ to the direction of II Zw 71.

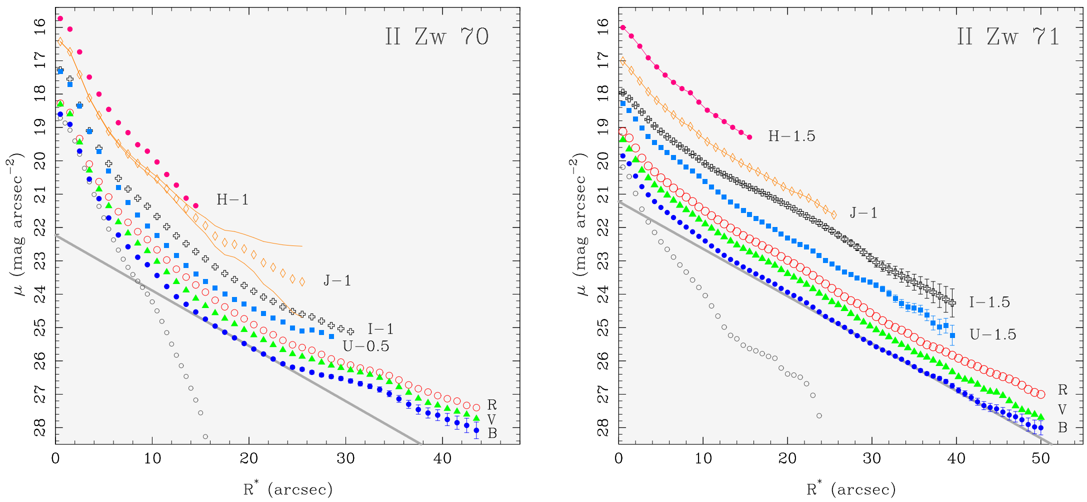

Figure 2: Surface brightness profiles from optical and NIR broad band images. Straight lines show fits to the intensity distribution of the exponential stellar LSB host of II Zw 70/71 in the B band (see text). Small open circles illustrate the surface brightness distribution of the emission in excess to the fits and represent the light contribution of the starburst component. The flattening of the optical profiles of II Zw 70 for $R^{\star} \gtrsim 24''$ is to be attributed to the low surface brightness extensions SE and NW (cf. Fig. 1c).

II Zw 70 (m_B=14.73 mag), comprises the luminosity output of extensions SE and NW (Fig. 1c). Roughly 20% of the emission registered below 26.2 B mag/$\square''$ or $\sim$3% of the total B band light of II Zw 70 is accounted for by the extension SE. This faint feature which can be traced on the available deep optical exposures out to $1\farcm65$ ($\sim$9 kpc) from the optical maximum of II Zw 70 deserves a closer inspection. The average colors of the unresolved continuum therein are substantially bluer ($B-R$ $\sim$+0.4 mag, $V-R \sim$ +0.16 mag) than those determined for the main body of the LSB host. Such colors lend support to the hypothesis that the SE extension is composed of stars having recently formed within the HI streamer connecting the BCDs rather than stars pulled-out from the LSB host of II Zw 70 during the interaction. The non-detection of Hα emission at the location of feature SE (Cairós et al. 2001) in connection with its blue broad band colors are consistent with an age of $\sim 10^8$ yr if an instantaneous formation process is assumed.

The results obtained here support the view that a substantial piece of information on the dynamical response and secular evolution of the stellar LSB component in interacting dwarf galaxies is potentially present in their very faint outskirts. A continued investigation of the formation process and nature of the extension SE/NW in II Zw 70/71 as well as the search for similar interaction-induced features in other pairs of dwarf galaxies is apparently of great interest.

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